1922MNRAS..82S.258.

and for many years he was regularly nominated by the Council as a "Lantern Committee" of one, to care for and improve it as occasion arose. He naturally occupied the front corner-seat next the lantern; and since he was kept away from the meetings by his war duties, that place has been filled for him by one of his old friends, in the hope that he would some day return to claim it. But the hope was vain.

H. H. T.

Abraham Barsley Taylor was born in Lincolnshire in 1856. He had little or no school education, as he began work at the early age of 9 years. Despite this great disadvantage he had a successful business career as a boot manufacturer, and was able in time to retire and follow up his astronomical interests. He had been attracted to the science when quite young, and later became a member of the Liverpool Astronomical Society. He died on 1921 June 29.

He was elected a Fellow of the Society on 1910 January 14.

Harry Samuel Williams, son of C. J. B. Williams, M.D., F.R.S., was born on 1840 March 4, and died on 1921 July 12. A scholar of St. John's College, Cambridge, he graduated in 1862 as 22nd Wrangler, and during part of his time at Cambridge he resided at the Observatory with Professor Challis.

Later he practised as a Solicitor in Bedford Row till 1882, when he retired and devoted himself to philanthropic work. He resided at Swansea for over thirty years, where he took part in many activities for the benefit of the poor, amongst other things building and maintaining at his own expense a school and mission room. He also worked zealously with the Young Men's Christian Association.

He married Grace Emily, daughter of George Watkins, Surgeon, of Guy House, Chepstow.

He was elected a Fellow of the Society on 1865 December 8.

Sherburne Wesley Burnham was born at Thetford, Vermont, U.S.A., on 1838 December 12. He was educated locally, and early took up the occupation of a shorthand reporter. About 1859 he was employed in New York, but during the Civil War he followed his occupation with the federal army at New Orleans. It was during this time that his attention was drawn to astronomy by the chance purchase of Burritt's *Geography of the Heavens*. The charts in this book induced him to study the heavens for himself, and soon he became an ardent amateur astronomer. His keenness for observing remained with him all his life, yet, except for four years (1888–1892) when he was officially attached to the Lick Observatory, he continued to work at his original profession. In 1892 he became Clerk to the U.S. Circuit Court in Chicago, and held this honourable position for a number of years. It was only when he was approaching his seventieth year that he retired from business.

Burnham purchased his first small telescope and exchanged it for his second when still at New Orleans, and for some time he appears to have regularly exchanged his telescope for another slightly better.

1922MNRAS..82S.258.

After the Civil War he settled down in Chicago quite near to the Dearborn Observatory, in which there had recently been installed by the firm of Alvan Clark & Sons an 18½-inch telescope—then the largest in the world. Probably the proximity of this great instrument inspired Burnham to get a better telescope for himself, and led to the purchase of his 6-inch telescope. Of the events which led to this purchase Burnham himself has told us in the Introduction to vol. i. of the *Publications of the Yerkes Observatory.*

"Some years later (about 1865) I obtained a 3¾-inch telescope, with an English object-glass, mounted equatorially by Fitz on a portable stand. This was just good enough to be of some use, and poor enough, so far as optical power was concerned, to make something better more desirable than ever. In 1869 I accidentally met Mr. Alvan G. Clark in Chicago . . . and made some inquiries of him about a small equatorial. This interview resulted in my ordering from the celebrated firm of Alvan Clark & Sons an equatorial of 6 inches aperture. I told them what I wanted and what I wanted it for. Every detail was left entirely to their judgment, stipulating only that its definition should be as perfect as they could make it, and that it should do on double stars all that it was possible for any instrument of that aperture to do. In due course of time this instrument was delivered, and was set up in an observatory prepared for it in the meantime. My attention, for some reason or other which I am unable to explain, had been almost exclusively directed to double stars, previous to this, while using the smaller telescope referred to."

Perhaps the reason why Burnham decided to devote his energies to double stars is to be found in the fact that one of the few astronomical books he possessed at this time was Rev. T. W. Webb's *Celestial Objects for Common Telescopes.* With his new telescope he began active operations, and soon both he and the telescope had become famous. It is familiar to every astronomer how he opened a new epoch in the discovery and observation of double stars. Following pioneer work by the Herschels the northern sky had twice been systematically surveyed for double stars: firstly, by W. Struve with the 9-inch Fraunhofer telescope at Dorpat 1824–27, and, secondly, by O. Struve with the 15-inch refractor at Pulkovo 1841–43. For nearly thirty years it was felt that all the double stars which could be revealed with existing telescopes had been discovered, and that all that remained in this branch of astronomy was to measure and remeasure them. In 1870 Burnham with only a 6-inch telescope began to discover new ones. His first catalogue, containing 81 new double stars, discovered in the years 1870–72, was published in the *Monthly Notices* for 1873. In congratulating him on his work Rev. T. W. Webb, himself a distinguished observer, probably voiced the opinion of all astronomers when he warned Burnham that his discoveries could not continue for very long for want of material. But still the discoveries went on, and list after list of new double stars appeared. It was some time before the full significance of Burnham's work was realised. The fact was that the Struves had detected the easy and fairly easy double stars, while Burnham was finding difficult and very difficult ones. The difficulty in detecting and ob-

1922MNRAS..82S.258.

serving double stars depends not only on their separation, but also on the brightness of the components. A considerable number of the new double stars which Burnham discovered can be roughly divided into two classes: (1) very close pairs (separation under 1″) in which the components are not too unequal and fairly bright; (2) wider pairs up to 10″ or more in which the brighter star is at least as bright as the seventh magnitude, and the companion so faint as to be almost invisible. In some extraordinarily difficult stars the components are markedly unequal and still separated by only 1″. The double stars discovered before Burnham's time were for the most part fairly easy objects with the telescopes then in use, and were discovered by what might be described as routine methods carefully and systematically applied. But most of Burnham's new double stars were discovered by minute examination of the star discs. He had a remarkable acuteness of vision and an eye wonderfully free from defects, while his telescope was practically perfect. If a star disc or the diffraction rings showed the slightest irregularity, he was not satisfied and returned to the star again and again till he was certain whether it was single or double.

Burnham's telescope had at first no driving clock and no micrometer. However, he contrived to turn the telescope by a weight attached to a cord wound round the polar axis. In this way he was able to make fairly accurate observations in position angle, but only estimates of the distances. The lack of measures by Burnham himself was supplied by his friend Baron Dembowski, the most accurate observer of that time, who devoted a great deal of his time to measuring the new double stars. Burnham has told us that the "kindly criticism and genial enthusiasm of Dembowski were always an inspiration to him"; but from the life Burnham led he does not appear to have required much inspiration from others. During the day he was occupied at his profession, but when the night was fine he worked till daylight drove him to bed. His work soon brought him into friendly personal relations with astronomers in Europe as well as in his own country. The finest telescopes in the country were placed at his disposal or pressed into his service. The life he led at this time may be indicated by a few short extracts from the introduction to his fifth catalogue published in the *Monthly Notices* for 1874 November.

"Unlike the four preceding catalogues to which my 6-inch refractor has alone contributed, the double stars contained in this have been found with apertures varying from 6 to 26 inches. . . . Passing through Washington . . . I had the pleasure of using the magnificent 26-inch recently erected. I had only one good night, and the 14 double stars in the following pages were all observed on that occasion. The time was principally spent in examining prominent stars, or familiar localities, in order to lose no time in determining places by reading circles, etc. . . . Before his departure for China on the Transit of Venus expedition, Prof. C. A. Young kindly placed the 9.4-inch refractor of the Dartmouth College Observatory at my disposal during a contemplated stay of a few weeks not far from that place . . . The double stars found with the 18·5-inch refractor of the Dearborn Observatory have been incidentally picked up at occasional visits."

1922MNRAS..82S.258.

Burnham continued to observe double stars on all possible occasions throughout his life. Besides the instruments already mentioned, he observed with the 15-inch telescope of Washburn Observatory, the 16-inch of the Warner Observatory, the 12-inch and 36-inch of the Lick Observatory, and, finally, the 40-inch of the Yerkes Observatory. In 1888 he accepted an official appointment at the Lick Observatory, but after four years he returned to Chicago. In his earlier years he had spent most of his time discovering double stars, but gradually he devoted a larger and larger portion of his time to measuring previously known but important or neglected stars. In all he discovered some 1340 new double stars. Of these 451 were discovered with the 6-inch telescope, 413 with the 18½-inch Dearborn telescope, and 198 with the 36-inch Lick Observatory telescope. Although the discoveries made with the larger telescopes include, on the whole, more difficult objects, some double stars discovered with the 6-inch are very difficult with any aperture. The binaries $\beta 80$, $\beta 151$, $\beta 359$, with periods well under 30 years and semi-major axes of less than $0''.75$, were discovered with the 6-inch. A much more difficult star $\beta 552$, the components of which are of the 7th and 10th magnitudes and are separated by less than half a second, was discovered with the 18½-inch Dearborn telescope, but in 1874 it had been suspected with the 6-inch telescope, and the position angle estimated at that time has proved to be substantially correct.

In his early work Burnham was handicapped by want of astronomical books. The information about known double stars was scattered through many works, some of them scarce and not easily accessible. With great zeal he set himself the laborious task of compiling a manuscript catalogue of all observations of double stars, borrowing books and visiting libraries as he found opportunity. In this way he collected together practically all published information relating to double stars within 121° of the pole. The catalogue was kept up to date with new observations, and went through three manuscript editions before it was finally published by the Carnegie Institute of Washington in two magnificent volumes, *A General Catalogue of Double Stars.* These volumes form the standard reference work, and give references to all observations published before 1906. The mere collecting of the material for these volumes was an enormous piece of work. It was not originally done with a view to publication, but when publication was assured Burnham spared no pains to make the catalogue as complete and perfect as possible. He devoted five years of his observing time to one work, *i.e.* two consecutive nights each week with the 40-inch telescope, making nearly 10,000 measures. Much time was spent in the rather uninteresting work of searching for double stars which had been discovered by others but insufficiently recorded. The value of Burnham's work is greatly enhanced by the fact that he observed nearly all known double stars which had been neglected. Without Burnham's measures our knowledge of a great number of double stars would be much more defective than it is.

When the *General Catalogue* was finished Burnham was 68 years of age. He might have been expected to retire from active work,

1922MNRAS..82S.258.

but such appears to have been far from his thoughts. In the formation of the catalogue he seems to have been struck with the frequent discordance between the proper motions of stars deduced from meridian observations and the proper motions relative to faint stars in the neighbourhood. He considered the difference due to errors in the meridian work, and not to the proper motion of the faint stars. To test this he made about 9500 measures with the 40-inch telescope between 1907 and 1912. These observations were published by the Carnegie Institution in a volume, *Measures of Proper Motion Stars.* His final observations made in 1912 and early in 1913 were published in *A.J.*, 738.

It is impossible in the space at our disposal fully to describe Burnham's work. With no astronomical education he quickly grasped the essentials of double-star work. By pushing the resolving power of the telescope to its extreme limit he discovered many rapidly revolving systems. With only one or two exceptions, the double stars discovered before his time have periods over a century, while for the great majority centuries must elapse before relative motion will be observed. Burnham's discoveries include many close bright pairs, and amongst these, especially when the proper motion is large, rapid orbital motion may be expected. Consequently the proportion of Burnham stars amongst those for which orbits can be computed is large. This proportion will increase in the near future, though ultimately the continuous work done more recently with the 36-inch refractor should produce a large number of systems of short period.

We have mentioned something of the enormous amount of work Burnham accomplished, and of its value in filling gaps left by other observers. But our chief reason for indebtedness to him is the accuracy of his work. The accuracy of the work of W. Struve is well known, and Burnham has said of Dembowski that he made no mistakes. Burnham too made no mistakes. But the true value of this tribute to his work can only be reckoned along with the extremely difficult nature of many of the observations which he made. When he stated that a star was single it was single within the resolving power of his telescope, and when he indicated a direction of elongation that direction was never many degrees in error. In their attempts to measure very close double stars many observers make spurious observations. But such are not to be found amongst Burnham's measures. A single observation by Burnham is an unfailing comfort to the orbit computer when dealing with a close double star, and may be relied upon against any contrary evidence of his contemporaries.

He was essentially an amateur, although his work ranks with the greatest professional astronomers in any branch of the science. The work was undoubtedly heavy, and he himself realised it when in 1899 he wrote in the Introduction to the *General Catalogue* of his own stars, "With the exception of the four years 1888–1892, all this astronomical work, with the telescope and otherwise, has been done when eight or more hours of at least six days in the week were more or less occupied with other and very different affairs of life." Yet he continued to observe as long as he had physical strength, no matter how

1922MNRAS..82S.258.

much it involved. For 17 years, 1895–1912, he stayed at Chicago, and regularly went each week-end to observe with the 40-inch at the Yerkes Observatory through two consecutive nights, although each visit involved a journey of 160 miles, with a three-mile walk frequently through snow to the observatory. Can any similar record of work be found anywhere?

Burnham was the founder of modern double-star astronomy. His influence has been world-wide, and in his own country the work which he initiated is being nobly pursued. He was sincere and thorough in all his work, and had faith in his own observations and in his own opinions. Always unwilling to draw conclusions from insufficient data, he never believed in unseen disturbing bodies to explain discordant observations. He avoided everything sensational, and for half a century consistently adhered to the subject he had chosen and refused to leave it for more modern fields of research.

Burnham was well known to a large number of astronomers, and many have told of the cordiality with which he welcomed them to Chicago. Foreign astronomers passing across America often made a point of calling upon him to enjoy his society for a few hours. Although he made great contributions to science, he was broad-minded and had many interests in life. He was a great lover of Dickens, and often spoke of visiting London with a view to searching out the places mentioned in the novels. By his friends he is remembered as one of the best of mankind. One of them has written, "Simple and sincere, loving the truth and hating all pretence of sham, given to caustic speech but ever showing a kindly heart; a tireless worker and full of the joy of living, he was a rare comrade whose friendship made life a little better worth living."

His work was honoured at home and abroad. He was given honorary degrees by Yale University and the North-Western University. In 1894 he was awarded the Gold Medal of our Society, and ten years later the Lalande Prize of the Paris Academy of Sciences.

Burnham married in 1868, and is survived by a widow and six children, three sons and three daughters, as well as a number of grandchildren.

He died on 1921 March 11.

He was elected a Fellow on 1874 November 13, and an Associate on 1898 December 9. J. J.

WILHELM FOERSTER was born on 1832 December 16 at Seydel, Silesia, being the second son of Friedrich Foerster, a cloth merchant. After early studies at Breslau he entered Berlin University in 1850. Humboldt's and Littrow's works had kindled an interest in astronomy, which he studied under Encke, and subsequently under Argelander at Bonn. In 1855 he became second assistant at Berlin Observatory, being made first assistant in 1860, on Bruhns's departure to Leipzig. He was appointed Director in 1865 on Encke's retirement. He had already been designated supernumerary Professor in 1863, in recognition of his work on the history of astronomy. In 1866 Auwers was elected to the Berlin Academy, and an intimacy between him and Foerster